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☐ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT (\$) 330

Complete if Known

Application Number	09/995418
Filing Date	27 November 2001
First Named Inventor	Kristina H. McVicker
Examiner Name	Brian K. Talbot
Art Unit	1762
Attorney Docket No.	FER-289

METHOD OF PAYMENT (check all that apply)

☐ Check ☐ Credit card ☐ Money Order ☐ Other ☐ None

☒ Deposit Account:

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060625

Ferro Corporation

The Director is authorized to: (check all that apply)

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FEE CALCULATION

1. BASIC FILING FEE

Large Entity		Small Entity		Fee Description	Fee Paid
Fee Code	Fee (\$)	Fee Code	Fee (\$)		
1001	770	2001	385	Utility filing fee	
1002	340	2002	170	Design filing fee	
1003	530	2003	265	Plant filing fee	
1004	770	2004	385	Reissue filing fee	
1005	160	2005	80	Provisional filing fee	
SUBTOTAL (1) (\$)					

2. EXTRA CLAIM FEES FOR UTILITY AND REISSUE

		Extra Claims		Fee from below		Fee Paid
Total Claims		-20** =		X		
Independent Claims		-3** =		X		
Multiple Dependent						

Large Entity		Small Entity		Fee Description
Fee Code	Fee (\$)	Fee Code	Fee (\$)	
1202	18	2202	9	Claims in excess of 20
1201	86	2201	43	Independent claims in excess of 3
1203	290	2203	145	Multiple dependent claim, if not paid
1204	86	2204	43	** Reissue independent claims over original patent
1205	18	2205	9	** Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) (\$)

**or number previously paid, if greater; For Reissues, see above

FEE CALCULATION (continued)

3. ADDITIONAL FEES

Large Entity Small Entity

Fee Code	Fee (\$)	Fee Code	Fee (\$)	Fee Description
1051	130	2051	65	Surcharge - late filing fee or oath
1052	50	2052	25	Surcharge - late provisional filing fee or cover sheet
1053	130	1053	130	Non-English specification
1812	2,520	1812	2,520	For filing a request for <i>ex parte</i> reexamination
1804	920*	1804	920*	Requesting publication of SIR prior to Examiner action
1805	1,840*	1805	1,840*	Requesting publication of SIR after Examiner action
1251	110	2251	55	Extension for reply within first month
1252	420	2252	210	Extension for reply within second month
1253	950	2253	475	Extension for reply within third month
1254	1,480	2254	740	Extension for reply within fourth month
1255	2,010	2255	1,005	Extension for reply within fifth month
1401	330	2401	165	Notice of Appeal
1402	330	2402	165	Filing a brief in support of an appeal
1403	290	2403	145	Request for oral hearing
1451	1,510	1451	1,510	Petition to institute a public use proceeding
1452	110	2452	55	Petition to revive - unavoidable
1453	1,330	2453	665	Petition to revive - unintentional
1501	1,330	2501	665	Utility issue fee (or reissue)
1502	480	2502	240	Design issue fee
1503	640	2503	320	Plant issue fee
1460	130	1460	130	Petitions to the Commissioner
1807	50	1807	50	Processing fee under 37 CFR 1.17(q)
1806	180	1806	180	Submission of Information Disclosure Stmt
8021	40	8021	40	Recording each patent assignment per property (times number of properties)
1809	770	2809	385	Filing a submission after final rejection (37 CFR 1.129(a))
1810	770	2810	385	For each additional invention to be examined (37 CFR 1.129(b))
1801	770	2801	385	Request for Continued Examination (RCE)
1802	900	1802	900	Request for expedited examination of a design application

Other fee (specify)

*Reduced by Basic Filing Fee Paid

SUBTOTAL (3) (\$) 330

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Date

6/4/04

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4 June 2004

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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of

Kristina H. McVicker et al.

Serial No. 09/995,418

Filed: November 27, 2001

For: HOT MELT CONDUCTOR
PASTE COMPOSITION

Mail Stop Appeal Brief—Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Group Art Unit: 1762

Examiner: Brian K. Talbot

APPEAL BRIEF

Sir:

This Brief is filed in triplicate in accordance with 37 CFR 1.192(a) in support of the Notice of Appeal in the above noted application that was mailed on April 5, 2004.

06/08/2004 AWONDAF1 00000090 060625 09995418

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Applicants: Kristina H. McVicker et al.
Serial No. 09/995,418
Filed: November 27, 2001
Art Unit: 1762

I. REAL PARTY IN INTEREST

The real party in interest or owner of the present application and the technology and inventions embodied therein is The Ferro Corporation, an Ohio Corporation, whose principal place of business is 1000 Lakeside Avenue, Cleveland, Ohio 44114. An assignment transferring rights from the inventors to The Ferro Corporation was recorded February 26, 2002 at Reel 012913, Frame 0304.

II. RELATED APPEALS AND INTERFERENCES

The application is not involved in an interference and there are no related appeals.

III. STATUS OF THE CLAIMS

Application 09/995,418 was originally filed on November 27, 2001 with twenty (20) claims. In a first Office Action, mailed June 24, 2003 - Paper No. 8, the Examiner rejected all pending claims (1-20) under 35 U.S.C. 103(a) as being unpatentable over Starz et al., DE 38 04 831 in view of either Ross, U.S. 4,219,448, Hanoka, U.S. 5,698,451 or Amick et al., U.S. 5,320,684. Applicants filed Amendment A on November 21, 2003 amending claims 1 and 16, and adding new claim 21.

On January 9, 2004, Examiner mailed a second and final office action – Paper No. 20040105, repeating the rejections of the first office action, and extending them to include claim 21. The rejection was based on the references cited in the first office action in further view of Tobias, et al., U.S. 5,286,288.

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On April 5, 2004 Applicants filed a Notice of Appeal from the decision of the Examiner mailed January 9, 2004 finally rejecting claims 1-21. Accordingly, claims 1-21 are currently pending in the application, and all said claims are pending on appeal. The pending claims, in their current form, are set forth in Appendix A, which is attached hereto for the convenience of the Board.

IV. STATUS OF AMENDMENTS

No amendments were filed in the application subsequent to the final rejection, Office Action 2, mailed January 9, 2004 - Paper No. 20040105.

V. SUMMARY OF THE INVENTION

The invention relates to a hot melt conductor paste composition ("HMCP") suited for use in the fabrication of electronic devices such as photovoltaic (PV) cells. The inventive HMCP is a solid at room temperature (ca. 25°C) but melts at relatively low temperatures, in the range of 35 to 90°C. The HMCP comprises conductive particles and glass particles, dispersed in a thermoplastic polymer system. The thermoplastic polymer system may comprise long chain linear primary alcohols (C₁₄ to C₂₀), cellulose ether, and long chain fatty acids (C₁₂ or higher). Inasmuch as the HMCP in accordance with the present invention is a solid at room temperature, it facilitates storage and handling of the composition. Further, the melted paste rapidly solidifies after application and requires no subsequent drying step.

Another aspect of the present invention is a method of forming a conductive pattern on a PV cell. The method comprises heating a HMCP of the present invention

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to a temperature above the melting point but below the volatilization temperature of the thermoplastic polymer system; applying the HMCPC to a silicon substrate by conventional application methods, and firing the substrate to form a conductive pathway.

VI. ISSUES

The sole issue presented for review by the Board of Patent Appeals and Interferences is whether claims 1-21 are properly rejected under 35 U.S.C. 103(a) as being unpatentable over Starz et al., (DE 38 04 831) in view of Ross (U.S. 4,219,448) or Hanoka (U.S. 5,698,451) or Amick et al., (U.S. 5,320,684) in further view of Tobias et al., (U.S. 5,286,288).

VII. GROUPING OF CLAIMS

With respect to the rejections under 35 U.S.C. § 103(a), the patentability of the pending claims (1-21) should be should be considered together.

VIII. ARGUMENTS

For the reasons set forth below, Applicants respectfully submit that claims 1-21 are patentable over the cited references.

- a. Claim 1 is patentably distinct over Starz, in view of Ross or Hanoka or Amick, and in further view of Tobias because the combination of Tobias with Starz and any of Ross, Hanoka, or Amick is improper under 35 U.S.C. 103(a).
 - i. Claim 1. A hot melt conductor paste composition comprising from about 50% to about 90% by weight of conductive particles consisting

essentially of either silver or aluminum and up to about 50% by weight of glass particles dispersed in a thermoplastic polymer system, wherein the paste composition is a solid at 25°C and melts at a temperature within the range of from about 35°C to about 90°C.

ii. Standard for an Obviousness Rejection

The standard for an obviousness rejection is defined by 35 U.S.C. § 103(a). The Examiner bears the burden of establishing a *prima facie* case of obviousness. *In re Rijckaert*, 28 U.S.P.Q.2d 1955, 1956 (Fed. Cir. 1993). If the references cited by the Examiner fail to establish a *prima facie* case of obviousness, then the rejection is improper and should be overturned. *See In re Fine*, 837 F.2d 1071, 5 U.S.P.Q.2d 1596, 1598 (Fed. Cir. 1988). A proper analysis of prior art references underlying an obviousness rejection requires, *inter alia*, consideration of two factors: (1) whether the prior art would have suggested to those of ordinary skill in the art that they should make the claimed composition or device, or carry out the claimed process; and (2) whether the prior art would also have revealed that in so making or carrying out, those of ordinary skill would have a reasonable expectation of success. *In re Vaeck*, 947 F.2d 488, 473, 20 U.S.P.Q.2d 1438, 1440 (Fed. Cir. 1991). Both the suggestion and the reasonable expectation of success must be found in the prior art, not in the applicant's disclosure. *Id.*

The burden of showing obviousness of a proposed modification is satisfied only by a particular reason why such a modification would be obvious. A general incentive does not make obvious a particular result. *In re Dueul*, 51 F.3d 1552 (Fed. Cir. 1995).

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The prior art references combined in an obviousness rejection must teach or suggest all the claim limitations. *In re Rokya*, 180 U.S.P.Q. 580 (C.C.P.A. 1974). An obviousness determination must be based on objective evidence of record, that is, the motivation to modify the reference must be contained in the reference itself. *In re Sang Su Lee*, 277 F.3d 1338, 1342 (Fed. Cir. 2002). This requirement cannot be dispensed with. See, e.g., *Brown & Williamson Tobacco Corp. v. Philip Morris Inc.*, 229 F.3d 1120, 1124-25 (Fed. Cir. 2000). Obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation to do so found either explicitly or implicitly in the references themselves or in the knowledge generally available to one of ordinary skill in the art. The test for an implicit showing is what the combined teachings, knowledge of one of ordinary skill in the art, and the nature of the problem to be solved as a whole would have suggested to those of ordinary skill in the art." *In re Kotzab*, 217 F.3d 1365, 1370, 55 U.S.P.Q.2d 1313, 1317 (Fed. Cir. 2000). See also *In re Fine, supra*, 5 U.S.P.Q.2d at 1596; *In re Jones*, 958 F.2d 347, 21 U.S.P.Q.2d 1941 (Fed. Cir. 1992).

The Examiner must always keep in mind limitations on the propriety of combining or modifying references and the motivation therefor, as developed by the courts. The mere fact that the Examiner has cited references, which, in toto, disclose all of the limitations of a pending claim, does not serve to defeat patentability of that claim. A prior art reference must be considered in its entirety, i.e., as a whole, including portions that would lead away from the claimed invention. *W.L. Gore & Associates, Inc. v. Garlock, Inc.*, 721 F.2d 1540, 220 U.S.P.Q. 303 (Fed. Cir. 1983), *cert. denied*, 469 U.S. 851 (1984), MPEP § 2141.02. The mere fact that references can be combined or

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modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination. *In re Fritch*, 972 F.2d 1260, 1265 (Fed. Cir. 1992); *In re Mills*, 916 F.2d 680, 16 U.S.P.Q.2d 1430 (Fed. Cir. 1990). The level of skill in the art, without more, cannot be relied upon to provide the suggestion to combine references. *Al-Site Corp. v. VSI Int'l Inc.*, 174 F.3d 1308, 50 U.S.P.Q.2d 1161, 1171 (Fed. Cir. 1999).

The showing or evidence of a suggestion, teaching, or motivation to combine references must be clear and particular. *In re Dembiczak*, 175 F.3d 994, 999, 50 U.S.P.Q.2d 1614, 1617 (Fed. Cir. 1999). If the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims *prima facie* obvious. *In re Ratti*, 270 F.2d 810, 123 U.S.P.Q. 349, 352 (C.C.P.A. 1959). It is improper to combine references where the references teach away from their combination. *In re Grasselli*, 713 F.2d 731, 743, 218 U.S.P.Q. 769, 779 (Fed. Cir. 1983).

iii. Overview of the Cited References

For convenience, the Starz patent may be referred to as the primary reference. Similarly, the Ross, Hanoka and Amick patents may be termed the secondary references, and the Tobias patent may be called the tertiary reference.

In maintaining essentially the same rejection in the second office action by adding a single reference to those cited in the first office action, the Examiner has implicitly admitted that the invention would be patentable over the originally cited references. Hence, we believe that the citation of the Tobias reference is crucial to the

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Examiner's rejection. Nevertheless, we discuss all cited references and how they are improperly combined to construct the sole rejection in the case.

1. The Starz Patent.

The patent to Starz, et al., DE 38 04 831, ("Starz") discloses an electrically conductive solvent-containing paint or coating used in the fabrication of solar cells. In particular, the coating contains (1) 50-75 wt% of silver powder, of which 0-50 wt% is aluminum powder, (2) 5-15 wt% of a thermoplastic polyester resin having a molecular weight of 10000 to 40000 and (3) 10-45 wt% of an organic solvent. The high-boiling organic solvent may include hydrocarbons, glycol ethers and glycol ether acetates. The electrically conductive paint is applied to amorphous silicon solar cells at temperatures under 200 °C by screen printing. As admitted by the Examiner, Starz does not disclose an ink melt that is solid at room temperature (25°C).

2. The Ross Patent

U.S. 4,219,448 to Ross discloses an ink composition, which when fired, forms an electrically conductive pathway on a solar cell. The ink comprises a metal frit, an organic binder and a fluxing agent. The metal frit can contain lead, cadmium, zinc, tin, bismuth, indium, antimony and aluminum. The binder may be poly vinyl alcohol, while the vehicle may be any solvent for the binder. The fluxing agent may be lithium fluoride or cesium fluoride. The ink is fired at 200-600 °C. Front and rear contacts are disclosed, on which firing may be performed simultaneously or sequentially. A glass component is not disclosed.

3. The Hanoka and Amick Patents

Because they disclose substantially cumulative subject matter and are treated as interchangeable by the Examiner, the patents to Hanoka and Amick are treated together herein. The Hanoka and Amick patents both relate to conductive pastes for use in fabricating solar cells. The claims of Hanoka relate to methods of making solar cells, while Amick teaches both photovoltaic cells and the methods for making them. Contacts of solar cells may be aluminum (rear) or silver (front). Both patents disclose simultaneous co-firing as well as sequential front-back firing. Both patents disclose glass frits in the conductive pastes: Amick up to 30% by weight glass, while Hanoka discloses up to 40% by weight glass. Both patents disclose the need to dry a green paste at 150°C after printing and before firing.

4. The Tobias Patent

The Tobias patent discloses a conductive hot melt printing ink suitable for continuous ink jet printing. The hot melt printing ink comprises an electrolyte and a solvent that dissolves and dissociates the electrolyte. The ink may be applied at 75°C to 175 °C, but is solid at room temperature (ca. 25 °C.) The conductors in the Tobias ink are electrolyte species—organic and inorganic salts—including KSCN, $\text{CF}_3\text{COSO}_3\text{Li}$, CH_3COOCs and CsI . The solvent is selected from the group consisting of alkanolamides and polyethylene glycol.

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- b. There is no motivation to one skilled in the art to combine the references as suggested by the examiner.

For the reasons discussed hereinbelow, the rejection of claim 1 over the cited prior art is improper and should be overturned. In an attempt to overcome the initial rejection by Examiner, Applicant amended claims 1 and 16 to clarify that it is the paste composition that is a solid at 25°C and melts in the range of about 35°C to about 90°C. The Applicant believes that these amendments were sufficient to patentably distinguish the claimed invention over the art cited in the first office action. This belief is supported by the fact that the Examiner found it necessary to apply a new reference to maintain the rejection after claims 1 and 16 were amended in Amendment A. This new reference is the Tobias patent, which discloses a conductive hot melt printing ink suitable for continuous ink jet printing. The Examiner contends that the combination of Tobias with Starz and any of Ross, Hanoka or Amick, is sufficient to render the claimed invention obvious.

The Examiner's final rejection is not well founded because no one skilled in the art would combine Starz or Tobias with any of the other cited references in an attempt to arrive at the claimed invention. In fact, taken as a whole, the cited references teach away from the combination (Starz + Tobias + any secondary reference), which forms the basis for the sole rejection that is grounds for the instant appeal.

The hot melt printing ink of Tobias comprises an electrolyte and a solvent that dissolves and dissociates the electrolyte. The inks may be applied (i.e., melt) at 75°C to 175°C, but are solid at room temperature (ca. 25°C.) The Tobias conductive inks are electrolyte species (organic and inorganic salts) including KSCN, CF₃COSO₃Li,

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CH₃COOCs and Csl. The solvent is selected from the group consisting of alkanolamides and polyethylene glycol.

Tobias is cited against the instant application because the Examiner believes Tobias teaches "conductive hot melt inks for printing which [are] solid at 25°C and melt at between 75-175°C," Office Action 2, page 3, point 3. The Examiner's citation is improper for several reasons. First, the Tobias patent pertains to ink jet printing, and not to the printing of electronic circuits. It is clear that at least the Starz, Amick, Ross, and Hanoka patents deal with screen printing a conductive paste on a substrate. The Tobias patent uses the term "print" more in line with common parlance, which is the application of ink onto a substrate in order to render an image. Moreover, the Tobias patent discloses the presence of an electrolyte as the conductive entity. Tobias does not disclose or suggest the use of metal or metal alloy particles as conductors. Indeed, it could not. An electrolyte is a solute, dissolved in a solvent to create a solution. The inks of Tobias are solutions. Metal particles would not function as the Tobias patent requires, i.e., as a conductive ionic solution.

The Examiner admits on the record that none of Starz, Ross, Hanoka or Amick individually or collectively, disclose an ink melt that is solid at 25°C, and that melts at about 35°C to about 90°C, Office Action 2, p. 2, point 3. The Examiner also admits that Starz does not disclose a coating composition having up to 50% glass particles, Office Action 2, p. 2, point 3. Glass forms no part of the invention embodied in the Starz patent. The Examiner contends that all of the secondary references disclose conductive pastes having up to 50% glass. As will be seen, this is factually incorrect.

In contrast to Tobias, the conductive composition of Starz is a liquid at room temperature, but not a solution. To be clear, the Starz composition is a liquid prior to drying steps disclosed therein. The Starz composition might best be characterized as a solvent-containing paint or lacquer. Metal particles would not dissolve in the organic solvents thereof, but remain suspended under agitation, or due to the viscosity of the solvated resin, or merely wetted. Given that Starz discloses a polyester resin, it is clear that Starz does not disclose a hot melt paste composition. In contrast to the inventive HMCPC, polyesters typically melt at much higher temperatures, in the range of 250 °C and higher, as is known in the art. Hence, if the polyester resin of Starz were heated to temperatures of about 35°C to about 90°C as in the instant invention, it would not melt. Also, it is pointed out that the electrically conductive paint is applied to amorphous silicon solar cells at temperatures under 200°C by screen printing, because amorphous silicon solar cells will lose hydrogen (dehydrogenation) at temperatures over 200°C, col. 1, ll. 39-41. In fact the wording is quite specific: only those screen-printing preparations that can be dried or cured under 200°C may be used to coat solar cells made of amorphous silicon, col. 1, ll. 33-36.

Unlike the inventive composition, the Starz composition is liquid at room temperature. Starz discloses an electrically conductive coating composition containing 10-45 wt% of an organic solvent in which a polyester resin is dissolved. Suitable organic solvents in the practice of the Starz patent include high boiling compounds from the class of hydrocarbons (for example mineral spirits) or from the class of the glycol ethers or glycol ether acetates (for example butyldiglycol, ethylglycolacetate, and ethyldiglycolacetate), col. 2, ll. 27-31. The electrically conductive coating is applied to

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amorphous silicon solar cells at temperatures under 200 °C by screen printing, and dried also at temperatures under 200°C, col. 2, ll. 10-13; claim 1.

The secondary references are cited as interchangeably disclosing "fabricating contacts for solar cells which incorporate coating compositions which include metal particles, binders, organic vehicles, and [up to 50%] glass frit," Office Action 2, p. 2, point 3. Although the Examiner cites the abstracts of the three secondary references, these assertions are not supported therein. In fact, there is no mention of any specific amount of a glass frit in any of the abstracts of the Ross, Amick or Hanoka patents.

Further, the conductive compositions of the secondary references are metal frit-containing conductive inks or pastes suited for use in electronic circuitry, and would not be useful in liquid ink jet printing. Hence their combination with Tobias is improper.

The Ross patent does not disclose a glass frit. Ross discloses an ink composition, which when fired, forms an electrically conductive pathway on a solar cell. The ink comprises a metal frit, an organic binder and a fluxing agent. The metal frit may contain lead, cadmium, zinc, tin, bismuth, indium, antimony and aluminum. The binder may be polyvinyl alcohol, while the vehicle may be any solvent for the binder. The fluxing agent may be lithium fluoride, or cesium fluoride.

Unlike the present invention, Ross does not disclose a glass component, but actually teaches away from the use of glass in a conductive paste or ink. In order to save firing costs, Ross instead uses a metal frit, rather than a glass frit, to form the conductive pathways. "Because the [disclosed] metals have a considerably lower melting point than most glass frits previously utilized, lower firing temperatures are possible," col. 3, ll. 48-50. Further, metal oxides are viewed as undesirable in Ross: "a

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fluxing agent may be added to...dissolv[e] undesired oxide," col. 2, ll. 53-55. The firing temperatures in Ross range from about 200°C to about 600°C, with 300°C preferred, col. 5, ll. 7-9, 13. The fact that Ross does not disclose a glass component means that it is not interchangeable with Hanoka and Amick. It further indicates that Ross is not combinable with Starz. Combining Ross and Starz would change the mode of operation of at least Ross, which has as a goal the capability of firing a conductive paste at a lower temperature than that required when a glass frit is used. Because silver melts at 961°C and aluminum melts at 620°C, the firing temperatures disclosed in the Ross patent (200 to 600°C) would not be effective in sintering the metal particles (aluminum and silver) in the Starz composition. Hence Starz and Ross are not combinable.

In the Tobias patent, it is noted, "[t]o sustain the electric charge required for continuous ink jet printing, the electrolyte ions must dissociate in the ink composition, thereby allowing ionic separation upon application of an external electric field," col.2, ll. 19-23. The ink of Tobias is "a hot melt ink composition [] compris[ing] an electrolyte, and an electrolyte-solvating and -dissociating compound selected from the group consisting of alkanolamides and polyethylene glycol," col. 2, ll. 59-63. The ink of Tobias could not be substituted for the ink of the present invention inasmuch as Tobias' ink is an electrolyte solvating solution, which solvates ionic salts, whereas the inventive inks must contain metal (i.e., a conductive non-oxidized metal) to function as a solar cell contact.

It is unclear why the Examiner cites Tobias in his rejection. A rejection under 35 U.S.C. §103(a) may be based on a combination of one or more prior art references. If the proposed modification or combination of the prior art would change the principle of

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operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims *prima facie* obvious. *In re Ratti*, 270 F.2d 810, 123 U.S.P.Q. 349, 352 (C.C.P.A. 1959). In order to properly combine the Tobias reference with Starz and the secondary references, they would have to be combined in such a way as to leave their modes of operation intact. Unfortunately, this is not possible. Because Tobias relates to ink jet printing using an ionic solute, because Starz relates to an electrically conductive paint or lacquer having metal particles and a solvent, and because Ross specifically disclaims a glass composition, the references are not combinable to afford the present invention.

It is difficult to determine which aspects of each prior art reference the Examiner seeks to combine. It appears that the Examiner cited Tobias for the concept of a hot melt ink that is solid at 25°C and melts at 75°C to 175°C. However, looking only to the prior art (and not the instant disclosure), there has been no showing that a conductive paste containing metal particles can be solid at 25°C yet melt at 35-90 °C.

The Examiner further states that it would have been obvious to modify Starz in combination with any of the secondary references "by making it a hot melt as evidenced by Tobias" because of the capability to avoid harmful solvents and eliminate drying steps. All of Starz, Ross, Hanoka and Amick disclose a drying step. Tobias does not disclose a drying step, but this is because the ink dries after it is printed on paper. There is no disclosure or suggestion of drying to eliminate volatile organics prior to firing in Tobias because there is no firing in Tobias. There is also no showing that the ionic inks of Tobias would operate in tandem with the teachings of Starz and any of the secondary references to form an electronic circuit.

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Significantly, in the present invention, the composition must be conductive after printing and firing, i.e., as a finished solar cell. This is also true of the compositions of the primary and secondary references. However, as regards Tobias, the conductive printing ink must be conductive while in liquid form—it is irrelevant whether the ink is conductive in solid form. Further, because the conductivity of a dilute ionic solution is based largely upon mobility of ions in solution, it follows that a frozen ionic solution (i.e., solid at room temperature) would not conduct electricity. The principles of action leading to electrical conductivity between Tobias and the present invention are entirely different, hence Tobias could not be combined with any other cited reference to achieve the claimed invention. For all of the reasons set forth hereinabove, the rejection of claim 1 is improper and should be overturned.

Because the Examiner does not break down his rejection as it relates to each pending claim, it is difficult to determine which aspect of each reference is combined with other references to allegedly render each claim obvious. With reference to claims 2 to 15 that depend from independent claim 1, and with reference to claims 17-20 that depend from independent claim 16, it is an axiomatic principle of patent law that if a product or process does not infringe an independent claim of a patent, then such product or process cannot be found to infringe any claim that depends from the non-infringed independent claim. See e.g., *Wahpeton Canvas Co., Inc.*, 870 F.2d 1546, *In re Fine*, 5 U.S.P.Q. 2d at 1600. Additional reasons, set forth hereinbelow, militate in favor of overturning the rejections of the remaining claims.

i. Claim 2.

For the following reason discussed hereinbelow, the rejection of claim 1 over the cited prior art is improper and should be overturned. Claim 2 is nonobvious because it depends from claim 1, previously shown to be patentable. Separate reasons for the patentability of claim 1 include that no cited reference discloses or suggests the use of a C₁₂ or higher fatty acid in a HMCP. The only mention of a fatty acid in the cited art is in Tobias. However, the citation of Tobias in the present case is inapposite because Tobias deals with an electrolyte solution used as ink in an ink jet printing operation. No one skilled in the art would refer to Tobias for the suitability of fatty acids in conductive paste compositions of the present invention because Tobias deals with ink jet printing.

ii. Claim 3.

The rejection of claim 3 over the cited prior art is improper and should be overturned. Claim 3 is nonobvious because none of the cited references, alone or in any combination, disclose or suggest the use of a HMCP comprising at least one glass frit comprising by weight from about 60% to about 95% PbO, up to about 30% SiO₂, up to about 15% B₂O₃, up to about 10% Al₂O₃, up to about 10% ZrO₂, up to about 5% P₂O₅, and up to about 5% RuO₂. For these reasons, the rejection of claim 3 over the cited prior art is improper and should be overturned.

iii. Claim 4.

The rejection of claim 4 should be overturned. Claim 4 is nonobvious in view of the cited references because no cited reference, alone or in combination, discloses or suggests the use of a conductive hot melt paste composition wherein the conductive particles have a bimodal particle size distribution. A bimodal particle size distribution is desirable because the particles can be more closely packed thereby improving the

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conductivity of the finally fired circuit, Instant Application, paragraph 10. For these reasons, the rejection of Claim 4 over the cited prior art is improper and should be overturned.

iv. Claim 5.

The rejection of claim 5 is improper and should be overturned. Claim 5 is nonobvious because none of the cited references discloses a conductive particle having a D_{50} size less than 5 μm . The only disclosure of particle size in any cited reference is an aluminum powder particle size of less than 45 μm , preferably less than 20 μm , in Starz col. 2, ll. 19-21. The particles claimed in pending claim 5 are far smaller, with a majority of the particles having a D_{50} size less than 5 μm , which is important if the composition is applied by screen printing, Instant Application, paragraph 10. For this reason, the rejection of claim 5 should be overturned.

v. Claim 6.

The rejection of claim 6 is improper and should be overturned. No prior art reference nor their combination discloses or suggests that the glass frit of a hot melt conductor paste comprises by weight from about 75% to about 92% PbO , from about 10% to about 20% SiO_2 , up to about 7% B_2O_3 , up to about 5% Al_2O_3 , up to about 6% ZrO_2 , up to about 3% P_2O_5 , and up to about 3% RuO_2 .

vi. Claim 7.

The rejection of claim 7 is improper and should be overturned. No cited reference nor their combination discloses or suggests a hot melt conductor paste composition comprising at least one C_{14} or higher linear primary alcohol.

vii. Claim 8.

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The rejection of claim 8 is improper and should be overturned. No cited reference nor their combination discloses or suggests a hot melt conductor paste composition comprising at least two or more different C₁₄ to C₂₀ linear primary alcohols.

viii. Claims 9-10.

Claims 9 and 10 are patentable because they ultimately depend from claim 1, which was previously shown to be patentable.

ix. Claim 11.

The rejection of claim 11 is improper and should be overturned. No cited reference nor their combination discloses or suggests a hot melt conductive paste comprising isostearic acid. To the extent that the Tobias reference discloses a fatty acid, the citation of the Tobias reference to the present case is improper. Tobias deals with ink jet printing inks based on electrolyte (ionic) solutions, and not on conductive metal particles.

x. Claim 12.

The rejection of claim 12 is improper and should be overturned. No cited reference nor their combination discloses or suggests a hot melt conductor paste comprising conductive silver particles exhibiting a bimodal size distribution and a glass frit comprising by weight from about 75% to about 92% PbO, from about 10% to about 20% SiO₂, up to about 7% B₂O₃, up to about 5% Al₂O₃, up to about 6% ZrO₂, up to about 3% P₂O₅, and up to about 3% RuO₂, and a thermoplastic polymer system which comprises a blend of two or more different C₁₆ to C₁₈ linear primary alcohols and ethyl cellulose.

xi. Claim 13.

The rejection of claim 13 is improper and should be overturned. No cited reference nor their combination discloses or suggests the HMCPC of claim 12 further comprising at least about 0.1% by weight of one or more C₁₂ or higher saturated fatty acids.

xii. Claim 14.

The rejection of claim 14 is improper and should be overturned. No cited reference nor their combination discloses or suggests a HMCPC comprising aluminum flakes having a D₅₀ particle size of less than about 5.5 µm, glass particles comprising silica, and a blend of at least one C₁₆ or higher linear primary alcohol and ethyl cellulose.

xiii. Claim 15.

The rejection of claim 15 is improper and should be overturned. No cited reference nor their combination discloses or suggests a HMCPC further comprising at least about 0.1% by weight of one or more C₁₂ or higher saturated fatty acids.

xiv. Claim 16.

The rejection of claim 16 is improper and should be overturned. Claim 16 is essentially a method for forming a conductive pattern on a PV cell providing the hot melt conductor paste composition of claim 1, heating the paste composition to flow it but not volatilize it, applying the HMCPC to a substrate and firing the so coated substrate to completely burn out the organic materials, thereby forming a conductive pattern. Because claim 1 has been shown to be patentable, and because no cited reference nor their combination discloses or suggests such a method of forming a conductive pattern on a photovoltaic cell comprising, the rejection of claim 16 should be overturned.

xv. Claim 17.

The rejection of claim 17 is improper and should be overturned. No cited reference nor their combination discloses or suggests forming a conductive pattern on a PV cell comprising applying the HMCPC to a substrate using a screen having a mesh size of about 100 mesh to about 400 mesh.

xvi. Claim 18.

The rejection of claim 18 is improper and should be overturned. For the same reasons that claims 16 and 1 are patentable over the cited references, claim 18 is similarly patentable.

xvii. Claim 19.

The rejection of claim 19 is improper and should be overturned. No cited reference nor their combination discloses or suggests a method of forming a conductive pattern on a PV cell wherein the conductive particles comprise a blend of particles having a bimodal size distribution, wherein the glass frit comprises by weight from about 75% to about 92% PbO, from about 10% to about 20% SiO₂, up to about 7% B₂O₃, up to about 5% Al₂O₃, up to about 6% ZrO₂, up to about 3% P₂O₅, and up to about 3% RuO₂; wherein the thermoplastic polymer system comprises a blend of two or more different C₁₆ to C₁₈ linear primary alcohols and ethyl cellulose, and wherein the composition further comprises at least about 0.01% by weight of one or more C₁₂ or higher saturated fatty acids.

xviii. Claim 20.

The rejection of claim 20 is improper and should be overturned. No cited reference nor their combination discloses or suggests a method of forming a conductive

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pattern on a PV cell wherein the conductive particles comprise aluminum flakes having a D_{50} of less than about 5.5 μm , wherein said glass particles comprise silica, wherein said thermoplastic polymer system comprises a blend of at least one C_{16} or higher linear primary alcohol and ethyl cellulose, and wherein said composition further comprises at least about 0.01% by weight of one or more C_{12} or higher saturated fatty acids.

xix. Claim 21.

The rejection of claim 21 is improper and should be overturned. No cited reference or their combination discloses or suggests a method of forming a conductive pattern on a photovoltaic cell as disclosed in claim 16 with the added step of applying a second electronic paste material onto the solidified hot melt conductor paste composition prior to firing the substrate.

IX. Concluding Remarks

In sum, the Examiner has not met his burden in setting forth a *prima facie* case of obviousness in light of the cited prior art. The Examiner has only attempted to disclose the existence of five references, which when combined, disclose all of the elements of the claimed invention. In this case, however, the *prima facie* case fails for at least two reasons. First, the cited references, when combined, do NOT disclose all of the limitations of the claims on appeal, either explicitly or inherently. Second, the Examiner has shown no teaching, suggestion, or motivation to combine the references to support his rejection. Third, even if the references should be combined as required by the Examiner to support the rejection, the claimed invention would not result.

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X. CONCLUSION

In light of the foregoing, it is respectfully submitted that claims 1 to 21 are allowable over the prior references of record, and a ruling from the Board to that effect is therefore respectfully requested.

Respectfully submitted,
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APPENDIX A

The following 21 claims form the subject of the present appeal.

Claim 1 (once amended): A hot melt conductor paste composition comprising from about 50% to about 90% by weight of conductive particles consisting essentially of either silver or aluminum and up to about 50% by weight of glass particles dispersed in a thermoplastic polymer system, wherein the paste composition is a solid at 25°C and melts at a temperature within the range of from about 35°C to about 90°C.

Claim 2 (original): The hot melt conductor paste composition according to claim 1 further comprising at least 0.01% by weight of one or more C₁₂ or higher saturated fatty acids.

Claim 3 (original): The hot melt conductor paste composition according to claim 1 wherein said glass particles comprise at least one glass frit comprising by weight from about 60% to about 95% PbO, up to about 30% SiO₂, up to about 15% B₂O₃, up to about 10% Al₂O₃, up to about 10% ZrO₂, up to about 5% P₂O₅, and up to about 5% RuO₂.

Claim 4 (original): The hot melt conductor paste composition according to claim 1 wherein said conductive particles have a bi-modal particle size distribution.

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Claim 5 (original): The hot melt conductor paste composition according to claim 1 wherein a majority portion of said conductive particles comprise flakes having a D_{50} of less than about 5.0 μm .

Claim 6 (original): The hot melt conductor paste composition according to claim 3 wherein said glass frit comprises by weight from about 75% to about 92% PbO , from about 10% to about 20% SiO_2 , up to about 7% B_2O_3 , up to about 5% Al_2O_3 , up to about 6% ZrO_2 , up to about 3% P_2O_5 , and up to about 3% RuO_2 .

Claim 7 (original): The hot melt conductor paste composition according to claim 1 wherein said thermoplastic polymer system comprises at least one C_{14} or higher linear primary alcohol.

Claim 8 (original): The hot melt conductor paste composition according to claim 7 wherein said thermoplastic polymer system comprises a blend of two or more different C_{14} to C_{20} linear primary alcohols.

Claim 9 (original): The hot melt conductor paste composition according to claim 7 wherein said thermoplastic polymer system further comprises one or more cellulose ethers.

Claim 10 (original): The hot melt conductor paste composition according to claim 9 wherein said cellulose ether comprises ethyl cellulose.

Claim 11 (original): The hot melt conductor paste composition according to claim 2 wherein said C₁₂ or higher saturated fatty acid comprises isostearic acid.

Claim 12 (original): The hot melt conductor paste composition according to claim 1 wherein said conductive particles comprise a blend of a majority portion by weight of silver flakes having a D₅₀ of less than 2.5 µm and a minority portion by weight of flakes having a D₅₀ of greater than about 2.5 µm, wherein said glass particles comprise a glass frit comprising by weight from about 75% to about 92% PbO, from about 10% to about 20% SiO₂, up to about 7% B₂O₃, up to about 5% Al₂O₃, up to about 6% ZrO₂, up to about 3% P₂O₅, and up to about 3% RuO₂, and wherein said thermoplastic polymer system comprises a blend of two or more different C₁₆ to C₁₈ linear primary alcohols and ethyl cellulose.

Claim 13 (original): The hot melt conductor paste composition according to claim 12 further comprising at least about 0.1% by weight of one or more C₁₂ or higher saturated fatty acids.

Claim 14 (original): The hot melt conductor paste composition according to claim 1 wherein said conductive particles comprise aluminum flakes having a D₅₀ of less than about 5.5 µm, wherein said glass particles comprise silica, and wherein said thermoplastic polymer system comprises a blend of at least one C₁₆ or higher linear primary alcohol and ethyl cellulose.

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Claim 15 (original): The hot melt conductor paste composition according to claim 14 further comprising at least about 0.1% by weight of one or more C₁₂ or higher saturated fatty acids.

Claim 16 (once amended): A method of forming a conductive pattern on a photovoltaic cell comprising:

providing a hot melt conductor paste composition comprising from about 50% to about 90% by weight of conductive particles consisting essentially of either silver or aluminum and up to about 50% by weight of glass particles dispersed in a thermoplastic polymer system, wherein the paste composition is a solid at 25°C and melts at a temperature within the range of from about 35°C to about 90°C;

heating said hot melt conductor paste composition to a temperature above the melting point of the thermoplastic polymer system but below the temperature at which said thermoplastic polymer system begins to substantially volatilize;

applying said hot melt conductor paste composition to a silicon substrate by screen printing, pad printing, extrusion, or dispensing; and

firing said substrate to completely burn out all organic material in said hot melt conductor paste composition and form said conductive pattern.

Claim 17 (original): The method according to claim 16 wherein said hot melt conductor paste is applied by screen printing to said substrate using a screen having a mesh size within the range of from 100 mesh to about 400 mesh.

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Claim 18 (original): The method according to claim 16 wherein said firing temperature is within the range of from about 650°C to about 900°C.

Claim 19 (original): The method according to claim 16 wherein said conductive particles comprise a blend of a majority portion by weight of silver flakes having a D_{50} of less than 2.5 μm and a minority portion by weight of flakes having a D_{50} of greater than about 2.5 μm , wherein said glass particles comprise a glass frit comprising by weight from about 75% to about 92% PbO , from about 10% to about 20% SiO_2 , up to about 7% B_2O_3 , up to about 5% Al_2O_3 , up to about 6% ZrO_2 , up to about 3% P_2O_5 , and up to about 3% RuO_2 , and wherein said thermoplastic polymer system comprises a blend of two or more different C_{16} to C_{18} linear primary alcohols and ethyl cellulose, and wherein said composition further comprises at least about 0.01% by weight of one or more C_{12} or higher saturated fatty acids.

Claim 20 (original): The method according to claim 16 wherein said conductive particles comprise aluminum flakes having a D_{50} of less than about 5.5 μm , wherein said glass particles comprise silica, and wherein said thermoplastic polymer system comprises a blend of at least one C_{16} or higher linear primary alcohol and ethyl cellulose, and wherein said composition further comprises at least about 0.01% by weight of one or more C_{12} or higher saturated fatty acids.

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Claim 21 (original): A method of forming a conductive pattern on a photovoltaic cell comprising:

providing a hot melt conductor paste composition comprising from about 50% to about 90% by weight of conductive particles consisting essentially of either silver or aluminum and up to about 50% by weight of glass particles dispersed in a thermoplastic polymer system, wherein the hot melt conductor paste composition is a solid at 25°C and melts at a temperature within the range of from about 35°C to about 90°C;

heating the hot melt conductor paste composition to a temperature above the melting point of the thermoplastic polymer system but below the temperature at which the thermoplastic polymer system begins to substantially volatilize;

applying the hot melt conductor paste composition to a silicon substrate by screen printing, pad printing, extrusion, or dispensing;

allowing the hot melt conductor paste composition to cool to a temperature below the melting point of the thermoplastic polymer system such that it solidifies on the silicon substrate;

applying an additional electronic paste material onto the solidified hot melt conductor paste composition; and

firing the silicon substrate to completely burn out all organic material in the hot melt conductor paste composition and form the conductive pattern.